PATENT SPECIFICATION 771,334

Date of Application and filing Complete Specification: Dec. 22, 1954.

No. 37063/54.

Complete Specification Published: March 27, 1957.

Index at Acceptance:—Classes 8(1), C2(A4A : H); 122(1), B7(A8 : A10 : C : F4), G, H7, and 122(3), B3A22.

International Classification:—F01b. F04c. F06c, j.

COMPLETE SPECIFICATION.

Improvements in Single Acting Piston Machines.

I, FRIEDRICH HAGANS, a citizen of the Eastern Zone of Germany, of Kartauserstrasse 33, ERFURT, Eastern Zone of Germany, do hereby declare the invention, for which I pray that a Patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns single-acting piston machines, that is to say engines for developing motive power such as steam engines or driven machines such as compressors.

Piston engines are known in which the piston operates without touching the wall of the cylinder to eliminate the need for lubricants in the cylinder, such engines having the piston carried by a crosshead, to which said piston is connected by a flexible coupling in such a manner that the only movement possible is in a direction transverse to the axial direction.

Constructions also have been proposed in which the cylinder chamber is separated from the crank-case by a bushing, the purpose of which is to ensure, by means of separate sealing rings, that condensate, for example, in the case of steam engines, does not pass to the crankcase. With these constructions, however, it is necessary for oil to reach the cylinder wall, as it is necessary for the wall of the cylinder to be lubricated.

In the case of piston compressors for refrigerants it is essential that the refrigerant materials should neither find their way into the lubrication circuit nor escape, as this would reduce the efficiency of the refrigerating operation, owing to the continuous leakage losses taking place, and moreover, also many gases (e.g. ammonia) have a pressure at ordinary room temperature above atmospheric pressure which necessitates special measures being adopted for hermetically sealing the working space.

The object of the invention is to provide a piston machine construction utilising a crosshead which allows the piston to move concentrically in the cylinder, and avoids the need for oil and the cylinder wall, the crosshead serving not merely to guide the cylinder, but also seals the space off from the crank chamber. The concentric movement of the piston in the cylinder, together with adequate sealing action, are necessary for reliable operation in the case of cyclic processes.

In accordance with the present invention, there is provided a single-acting piston machine wherein the piston is directly and rigidly connected to a crosshead running in a guide bushing, said bushing extending into the cylinder with the crosshead having piston rings and oil scraper rings, and the piston carrying a labyrinth packing and running in the cylinder without making contact with the walls thereof.

The piston movement in the cylinder in combination with the sealing function of the crosshead and the labyrinth packing of the piston, ensure reliable operation. The crosshead guide bush is arranged preferably so that about a half extends in the cylinder, the other half in the crank-case. The external diameter of the upper part of the bushing is such that the piston wall is able to reciprocate without making contact with the bushing. The crosshead is adequately guided within the bushing and directly supports the piston crown, this being rigidly connected with the crosshead and running concentrically with it, for example by making a sliding fit of the parts. The provision of both piston sealing rings and oil scraper rings on the crosshead ensures that the space above the piston head is sealed off from the crank chamber.

In accordance with a further feature of the

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invention, a leakage gas collector is provided between the cylinder and crank chamber, this being in the form of a ring or a separate flange-mounted chamber. This chamber not merely collects any working substance which may leak past the piston, in order to convey it back to the working cycle, but it can also ensure that any lubricant which does find its way over from the crosshead guide is effectively withdrawn. The crank-case chamber may be kept at a pressure different from that of the collector chamber.

In a construction with a trunk piston, in which the piston is connected to the crosshead by means of rigid members such as rods for the purpose of allowing a contact-free movement to take place in the cylinder, it is particularly important for the piston and the crosshead to be machined accurately if the latter is to be utilised for sealing off the space from the crank-case.

In order to enable the two parts to be machined jointly, the invention provides for a clearance—in an axial direction—between the lower edge of the piston and the upper edge of the crosshead. This enables the already built-in parts, in their assembled state, to be machined jointly as a unitary structure, so that there can be no machining errors due to inaccuracies in the tooling machines, absolutely true running and complete concentricity being assured. With appropriate internal centering, parts machined by this method can be dismantled again at any time without concentricity errors occurring on re-assembly. Centering of this kind can be obtained, for example, by means of a conical connection in which the two parts can be gripped together by a twin screw (differential-thread screw).

With the elimination of cylinder lubrication the normal working upper temperature limit can be exceeded. Where steam engines are concerned, heat can be conserved by using materials with poor heat-conducting properties, e.g., ceramics, such as porcelain. This may be done either by the use of a ceramic cylinder bushing, for instance, or with pistons made of a material with poor heat-conducting characteristics. A greater proportion of heat is converted into work at the crank gear in the machine which is of reduced length compared with designs known hitherto, so that this measure—which, to ensure equal heat-expansion coefficients may be extended to the crosshead—enables the internal thermal efficiency of a machine of this type to be increased. With piston compressors, for example, this also enables use to be made of materials not subject to attack from the compression media, e.g., chlorine gas, SO_2, etc., while the danger of rust in the cylinder chambers of steam engines is eliminated, this being essential to the maintenance of the sensitive labyrinth packing. Here the piston may consist either wholly or partly of ceramic materials or others with bad heat-conducting properties; the piston-head, for example, may be fitted with a plate of such a substance.

In addition to preventing heat conduction from taking place to the crank gear, direct or indirect cooling may be used in order to ensure reliable operation; the inside of the crosshead, for example, may be cooled with sprayed oil, in which case it is advisable to adopt a separate cooling circuit for the lubricants or, in the case of smaller units, to divert the lubricant from the actual pressure-oil circuit used for the normal bearing lubrication and only cool the crossheads or their guide bushings. The main bearings can also be connected up to this circuit. It has been found in operation that this prolongs the life of the crosshead considerably, in particular reducing wear and tear.

By eliminating piston friction in the cylinder, the proposed form of construction enables the mechanical efficiency to be increased, and the sealing effected by the crosshead makes it possible to maintain different gas pressures in the machine chamber, one either side thereof. The increase in the overall thermal efficiency and also the improvement in the internal thermal efficiency are ensured by the use of materials with poor heat-conducting properties and at the same time highly resistant to heat, these materials also being lighter than steel, so that in addition by using such materials, there is a considerable reduction in the weight of the rotating masses and thus an increase in the r.p.m. in comparison with what can be obtained by merely eliminating piston ring friction. Owing to the internal cooling of the crosshead, the piston ring wear, and the bottling-up of heat are reduced.

The accompanying drawing shows, by way of a cross sectional view, a constructional example consisting of an engine driving a compressor.

In the drawing 1 denotes the two cylinders of a single-acting 90°-V piston engine driven compressor. In cylinder 1 on the right there is a built-in bushing 2, of hard porcelain for example, forming a cylinder. The trunk piston 3 and crosshead 4 which are of steel, are united by a screw 5, via a centering-fit. Between the lower edge 6 of the piston and the upper edge 7 of the crosshead, there is a clearance to ensure that the two parts can be turned and ground as a unitary structure. The connecting rod 8 engages with the crankshaft 9. The cross head 4 runs in a guide bushing B which extends down into the crank case and also up into the cylinder, so that the piston skirt moves with a clearance in the space between the upper part of the bushing B and the built in bushing 2. The conduit 10 is for the sprayed cooling medium which

discharges into the interior of the crosshead. To enable it to perform its function of sealing off the space above it from the crank-case 11, the crosshead 4 carries sealing rings 12, and to prevent oil from emerging from the crank-case 11 it also carries oil-scraper rings 13. The piston carries a labyrinth packing, and it will be noted that the leakage gas from the cylinder chamber must also pass up over the guide bushing B. Any leakage gas past the labyrinth packing enters the collector chamber 14, which is accommodated at the lower end of the cylinder 1, so that by means of the rings 12 a different pressure can be produced in the space in which the piston moves from that of the crank-case chamber 11. The arrangement of sealing could be such that the pressure in this space can be different from that obtained in both the cylinder and crank chamber. The drawing shows the cylinder of the engine with valve 15 constructed for direct flow, e.g. as a steam engine, while the other cylinder on the left has two automatic valves 16 and 17 and operates as a gas compressor on the alternating flow system. The labyrinth packing is provided on both pistons and consists of a number of grooves as shown in the left hand cylinder, or fine pitch screw threads. The crosshead and piston are united in both engine and compressor, but in the compressor, the two are united by welding instead of by a screw.

The grooves prevent oil, which might find its way between the guide bushing and crosshead if the scraper rings 13 do not function correctly, from leaking past the piston. The piston rings 12 ensure that no leakage of gas or steam reaches the chamber 11, so that this chamber is adequately separated from the leakage space 14.

It will be understood that any working steam or gas which should pass through the labyrinth packing, passes into the collector chamber 14, which serves to receive same. This chamber is sealed by a container 18, which functions as a trap, and any lubricating oil can be drained off through a suitable valve. The labyrinth packing causes an inertia in any oil tending to move past the piston, and so results in a sealing action.

The construction in accordance with the invention provides an engine which, by changing the cylinder head and altering the regulating gear (i.e. the valve assembly) and providing for suitable fuel injection, becomes a Diesel engine. The basic cylinder and piston and crank assembly remain unaltered, and it is immaterial what type of machine is assembled.

WHAT I CLAIM IS:—

1. A single-acting piston machine wherein the piston is directly and rigidly connected to a crosshead running in a guide bushing, said bushing extending into the cylinder with the crosshead having piston rings and oil scraper rings, and the piston carrying a labyrinth packing and running in the cylinder without making contact with the walls thereof.

2. A single-acting piston machine as claimed in Claim 1, wherein the piston and crosshead and also the cylinder consist wholly or in part, or individually or collectively, of a substance with poor heat-conducting properties such as porcelain.

3. A single-acting piston machine as claimed in Claim 1 or 2, wherein a clearance is provided between the piston and crosshead guide bushing, the space so formed being maintained at a pressure different from that obtaining in the cylinder above the piston and crank chamber.

4. A single-acting piston machine as claimed in any of the preceding Claims, wherein the crosshead or its path is incorporated in a cooling circuit.

5. A single-acting piston machine as claimed in any of the preceding Claims, wherein a cooling medium is sprayed on to the interior crosshead surface.

6. A single-acting piston machine as claimed in any of the preceding Claims, wherein a leakage gas collector is provided between the cylinder head and crank chamber, this collector being in the form of a ring or separate flange-mounted chamber.

7. A single-acting piston machine as claimed in Claim 6, wherein any leakage gas from the cylinder is led to the collector chamber at the lower end of the cylinder through labyrinth packing.

8. A single-acting piston machine comprising a cylinder in which the piston reciprocates without making contact with the wall of the cylinder, a labyrinth packing on the piston wall, a crosshead assembly consisting of a lower cylinder-like part having sealing and oil scraper rings running in a guide bushing, and an upper part to which the piston is rigidly attached so as to be truly concentric with the crosshead, the wall of said piston moving in a space between an upper part of the guide bushing and the cylinder wall, which space leads to a collector chamber, the lower part of the crosshead being within the engine crank chamber and connected by a connecting rod to the crankshaft.

9. A single-acting piston machine as claimed in any of the preceding Claims, wherein the cylinder head is detachable to enable other heads to be fitted.

10. A single-acting piston engine compressor driven substantially as herein described and also with reference to the accompanying drawing.

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771,334 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.